More Effectively Using Our Observing, Monitoring, Research and Education Infrastructure

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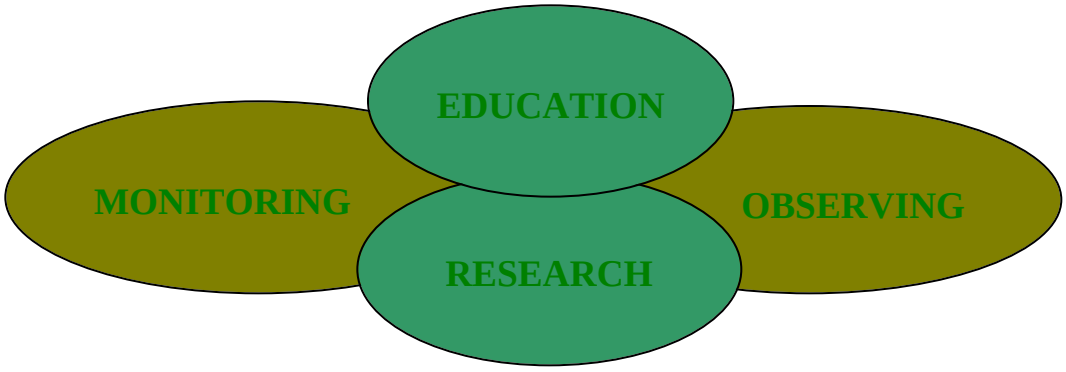
Contributing Authors

Bob Bailey, Oregon Department of Land Conservation and Development
Mike Deluca, Jacques Cousteau National Estuarine Research Reserve
Christine Gault, Waquoit Bay National Estuarine Research Reserve
Dominic Gregorio, California State Water Resources Control Board
Kerry Howard, Alaska Division of Governmental Coordination
Tony MacDonald, Coastal States Organization
Janice McDonnell, Jacques Cousteau National Estuarine Research Reserve
Tom Skinner, Massachusetts Executive Office of Environmental Affairs

Author and Panel Coordinator

David Keeley, Maine State Planning Office



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Introduction

This paper for the California World Ocean Conference seeks to assist the US Commission on Ocean policy in their deliberations on ways to strengthen and improve the management of the nation's coastal and ocean environment. It provides a series of specific recommendations. The authors invite comments that will further clarify these recommendations.

The basis for this paper are preliminary recommendations prepared by the Coastal States Organization for the Ocean Commission at their August 2002 meeting in Alaska. (These full recommendations may be found at www.sso.org/cso) The purpose of the Coastal States Organization (CSO) is to shape and advance a national agenda that enhances the protection of coastal and ocean resources of the Nation and which furthers the vision for the coasts shared by member States, Territories and Commonwealths. It is a membership organization representing the Nation's 35 coastal governors.

While the CSO August 2002 report to the Ocean Commission addresses four topics (governance; stewardship; monitoring, research, observing and education; and economics) this paper seeks to build only on the themes of monitoring, research, observing and education[1]. A final component is assessment. This integrates data and produces information.

The views stated in this paper are those of the authors and have not been placed before the CSO membership for their consideration.

[1] For the purposes of this paper the authors see significant and complimentary overlap in these terms. Broadly stated monitoring is the systematic collection of mission-driven environmental data to determine current conditions, trends and natural variations. Observing is the collection of real-time environmental data for a host of uses. Research is scientific investigation and scholarly pursuit of knowledge. Education is the presentation of information in a manner that people can take action.

SECTION 1: CREATE A FEDERATION OF OCEAN OBSERVING SYSTEMS

Substantial effort at the local, state, regional and national levels has focused on the design and implementation of a nation-wide network of linked and coordinated regional ocean observing systems that measure a common set of parameters using uniform methods and protocols that can be regionally and locally enhanced. The purpose of the network is to facilitate safe and efficient marine operations, ensure national security, manage living resources and marine ecosystems, ensure a sustainable food supply, mitigate natural hazards and ensure public health.

Such a system should provide continuous, long-term and real-time observations and predictions of ocean events and phenomena on a timely, integrated and sustained basis.

Through its design, the system should make effective use of existing resources and new technologies to address the needs of society for timely detection and prediction of coastal environmental conditions, such as changes in weather and sea state to changes in habitat and living marine resources.

Finally, the system should provide a source of data and information that contributes to public awareness of the condition and importance of the nation's coasts, oceans and Great Lakes.

CSO Recommendation #1 – Create a federation of coastal and ocean observing systems

A national coastal and ocean observing system should be governed by the following core set of principles, which should be used in the design and implementation of this federal-state system.

Principle #1 -- Demonstrated relevance to coastal and ocean management

Action: National legislation that establishes an ocean observing system should contain criteria requiring that the national oversight board and subsequent regional boards provide for substantive and significant representation of the user community.

Rationale: States are interested in the synthesis of data into products that managers can use to understand and manage the marine environment and ensure that the uses of the environment are not jeopardizing its sustainability. Therefore, states must be involved in the design and implementation of observing systems to ensure that data collected addresses pressing management issues. In Alaska, three good models have emerged that would advance the substantive and significant representation of the user community, as follows:

- The Bering Sea Strategy (Bering Seas: Final Report Bering Sea Ecosystem Project, 2000) identified a target audience for regional participation similar to that envisioned by the CSO recommendation. The audience includes researchers, managers, and those affected by management;

- The University of Alaska has initiated the first steps towards implementing an Alaska-wide consortium to develop the Coastal Alaska Observing System (CAOS). Although spearheaded by the University of Alaska, CAOS would be guided by an executive committee that includes representatives from the different user groups. The vision of CAOS is to provide quality comprehensive data and synthesized information products derived from a permanent observation network; and

- The state is using funds provided under the Coastal Impact Assistance Program (CIAP) to develop a catalogue of existing coastal resource information obtained from multiple users, and an online information system that will assist in coastal development permitting and planning. Information gaps identified through these projects will help determine priority information needs for the coastal management network.

Principle #2: Make local, state and regional investments in ocean observing

Action: Federal funding should be used to leverage and provide incentives for investment of local and state resources in a national ocean observing system.

Rationale: The need for an ocean observing system that addresses national priorities is well documented. Given the variability of the nation's coastal zone and the need for data specific to a region, it is appropriate to create mechanisms to collect local, state and regional investments that augment federal expenditures. These investments would be additive and build on a sustained federal system.

The principle and action recommend a reciprocal arrangement that creates both mechanisms to collect local, state, and regional investments to augment the federal expenditures, and also provides federal funding to encourage state participation in the ocean observing system. By way of example the Coastal Zone Management Act (CZMA) obligates states to provide a defined level of response to continue receiving federal funding. Using this as a model, participants within a federation of regional systems that are collecting data (e.g., using standard criteria and protocols) could receive federal funding to promote the system, teach the protocols, verify that the protocols were followed, and synthesize and present the data in a format that is useful to coastal managers and other user groups.

Principle # 3: Synthesize data into useful products

Action: National legislation that establishes an ocean observing system should authorize annual funding levels that provide significant resources, in a separate line item, for data

synthesis and product development. Further, this effort should be coupled with other ocean data management programs to maximize the nation's investment.

Rationale: Ocean observing and prediction systems should be tasked with generating data and products for the primary purpose of making data products. Coastal managers need synthesized products to make informed decisions. The specific products will vary by region and should be developed in close consultation with the end users. A few examples of these products include: a three-to-seven day forecast for harmful algal blooms; improved emergency management flood models showing wave run-up and storm surge predictions; coastal maps identifying sites most physically suited for net-pen aquaculture; and larvae and egg-transport maps for priority marine species.

To accomplish this, several key questions will need to be addressed:

- *Who is the target audience?* Examples include: land-use managers, permitters, subsistence hunters, regulators, and resource users in all sectors (e.g., oil and gas, fishing, mariculture, tourism, etc.)
- *What are their data needs? What decisions do they make?* Data needs for the audiences noted above include: the detection of erosion and sea level rises; navigation information; identification of suitable mariculture sites; and specific physical, chemical, and biological characteristics of proposed development sites, including how they change seasonally and over longer time periods. Generally, the types of decisions relate to evaluating the likely effects that proposed projects or land management decisions may have on coastal uses and resources. Ideally, users would have both "nowcasts" and forecasts of physical, chemical, and biological parameters.
- *Who will compile and synthesize the data?* Who compiles the data may be different for different uses and users. However, for the data to be useful, specific responsibility must be assigned if synthesis is to be guaranteed.
- *What format will be used to synthesize the data?* The Integrated Ocean Observing System (IOOS) is planning to rely on http: as the mechanism for transmitting data, but the format also needs to address whether the analysis is presented in tabular form, graphic form, written form, or a combination thereof. We assume the data would be provided for management, via the Internet. To be most useful, the combination approach whereby the information is conveyed in some combination of tabular, graphic, and written forms should be used.

Principle #4: Build state capacity

Action: National legislation that establishes an ocean observing system should contain statutory and authorization language that leverages and supports state efforts to use the intended data and products.

Rationale: The federal-state partnership required to make a national ocean observing system functional and useful will require an ongoing shared investment in building and maintaining local and state user capacity. Tools to achieve this include

workshops, training courses, development of software or printed materials, data processing models and hardware, technology transfer and state-level consultations.

Two suggested ways to build capacity in Alaska include:

- The Alaska Coastal Management Website disseminates available data, either directly or through links to the appropriate site. This website could be sustained and enhanced with such leverage;
- With CIAP monies, the state is developing a comprehensive database for State permitters. A continued source of funding for this effort would enable the data to be compiled into useful information for resource managers and other coastal partners.

SECTION 2: STRENGTHENING ENVIRONMENTAL MONITORING

Environmental monitoring of the coastal and marine environment is crucial to documenting status and assessing trends, evaluating the cause-effect relationships between stressors and impacts, and assessing the effectiveness of management actions. In this context, research is an important part of monitoring in that it:

- improves the ability to interpret monitoring data and assessment capability;
- assists in predicting impacts as a result of emerging trends; and
- allows forecasts and assessments of the impacts and benefits of management actions.

CSO Recommendation #1 – Establish a National Ocean and Coastal Resource Monitoring Center

An interagency national center is needed to integrate federal, regional and state monitoring efforts. It should facilitate coordination, data management and archiving, ensure quality control, scientific methods development, information dissemination, and regional and national scale assessments. A panel of representatives from ongoing monitoring and assessment programs should provide advice and guidance.

Action: National legislation is needed to create a national center that has specific linkages to other federal data collection efforts (e.g., Ocean.US, etc.) and provides for state and regional participation.

Rationale: Monitoring, observation and research programs are performed by a wide array of organizations in locations throughout the coastal ocean. These entities represent all levels of government, universities and other academic institutions, dischargers, and non-governmental organizations (NGOs). Their programs vary, among other things, in funding, sampling design and intensity, parameters tested, analytical methodology and data management protocols. Some coastal states and regions have better developed and intensive monitoring programs. These differences even manifest themselves within single states, where fiscal realities force the allocation of resources toward the coastal areas with the greatest population pressures and intensive impacts. In summary, the monitoring landscape in our coastal ocean is patchy and inconsistent. The establishment of a National Ocean and Coastal Resource Monitoring Center would assist by bringing consistency and additional resources, ultimately resulting in the ability to produce national scale assessments of ecosystem health.

Proposal: National legislation is needed to create an interagency national center to integrate federal, state and regional monitoring efforts. Key attributes of this center include:

- Facilitate coordination of monitoring programs. Encourage flexible, nested designs to allow state and region specific issues to be addressed in a national context. Provide seed funding for emerging regional programs;
- Assistance and guidance with sampling and statistical design;
- Standardization: laboratory inter-calibration exercises and quality assurance protocols;
- Scientific methods and technology development;
- Information dissemination, including providing training exercises and workshops;
- National data management system: maintain data and metadata standards for distributed data sets in each state/region. The Center would maintain a search engine capable of accessing these distributed data sets; and
- Perform national scale marine environmental quality assessments

CSO Recommendation #2 – Integrate federal monitoring programs

Elements of the nation's existing federal coastal and ocean monitoring programs, including EPA, NOAA, and USGS, need to be integrated to maximize outputs (e.g., expand data collection, integrate analysis, educate decision-makers, etc.), minimize duplication, and invest funds efficiently. Substantial materials exist on how this might be accomplished and are documented in the 2000 Clean Water Action Plan. In addition, this integration should extend to include relevant state and regional monitoring programs.

Action: Amend national legislation affecting the federal resource agencies that operate monitoring programs to require development and implementation of an integrated approach. Effectiveness measures of this effort might address reduced costs and greater efficiency, wider use of the data and information products, a greater understanding of the status of the marine environment, amendments to federal legislation and more thoughtful management decisions, etc.

Rationale: Currently a number of federal agencies perform or fund monitoring and associated research activities in the coastal ocean. Each of these monitoring programs is linked to the agency's mission and therefore concentrates on certain specific aspects of the marine ecosystem. Even when identical properties are being measured different data management protocols may make the integration of that information difficult. In addition, monitoring and research programs all rely on certain basic observations and measurements to support their specific investigations, and this may represent significant overlap or duplicity in effort among the agencies. While the work performed by each agency does satisfy the original intent and goal of that research or monitoring program, their collective efforts rarely provide a complete glimpse of the overall ecosystem's health. Thus an integrated monitoring program is needed that provides national, regional and local capabilities to measure, understand, analyze, and forecast ecological change (natural and anthropogenic) that can affect coastal economies, public safety and the integrity and sustainability of the nation's coastal ecosystems.

Proposal: Establish a Federal Interagency Ocean Monitoring Committee in conjunction with a National Ocean and Coastal Resource Monitoring Center. The mandate of this committee would be to reduce costs and duplicity, increase efficiency, ensure data comparability, and better integrate the design and results of federal monitoring activities. Another goal would be to encourage the measurement of parameters that lend themselves to being integrated, thereby allowing the assessment of ecosystem level health and trends. Participating agencies would employ adaptive management, based on committee recommendations regarding responses to observed environmental problems. The committee would also work cooperatively with States and Tribes to encourage communication, the coordination of monitoring efforts and the sharing of data in comparable formats.

CSO Recommendation #3 – Support regional monitoring

Regional monitoring programs designed by the states and use core parameters within a national framework (e.g., consistent protocols, standards for data exchange, etc.) are needed. These will augment and add value to current local, state and federal monitoring programs. Additional sampling sites, times and measurements may be required to address issues of significance to regional resource managers.

Action: Regions should receive support to develop and implement regional monitoring plans provided matching funds are available.

Rationale: A regional approach to monitoring is essential in order to determine the status and health of marine ecosystems. Regional monitoring programs may be employed to determine the overall health and status of marine biota. Preferably, regional monitoring programs would also answer questions regarding human health, such as those relating to seafood contamination and microbial pollution in recreational waters. Regional monitoring programs offer opportunities for integrating state and federal monitoring activities.

There are some regions that have emerging regional responses to state and federal monitoring needs. Effective regional monitoring programs may be exemplified by the southern California Bight ‘94 and ’98 surveys. Properties measured in Bight ‘98 included fish, benthic invertebrates, sediment and water quality, including beach microbiology. The Southern California Coastal Water Research Project, a joint powers agency with local, state, and federal government support, coordinated these surveys. The Bight ’98 survey was also an international effort, being performed from Ensenada in Mexico to Point Conception in California.

This type of program does not yet exist in most other parts of America’s coastal waters. Most of the coastal water monitoring conducted throughout the coastal states is associated with POTW NPDES permit requirements. These efforts, aside from being inconsistent and in some cases incompatible, only focus on very small areas in the vicinity of the discharge points. Such discharge specific monitoring programs do little to

illuminate the current condition of a region's water quality and ecosystem health. One way to encourage funding of regional programs is to have NPDES permits conditions designed to allow flexible use of monitoring resources and effort, when approved by the permitting agency, while still requiring an adequate level of effluent monitoring to assure permit compliance. Another problem is that relatively little monitoring is currently done with regard to storm water and nonpoint source discharges. The municipalities and other responsible parties involved in discharging storm water and nonpoint source pollution should contribute toward regional monitoring efforts.

Proposal: Federal and state government must provide leadership and funding to support existing and emerging regional monitoring programs. Regional programs should be nested within a national monitoring matrix. The core components of a regional monitoring program should include:

- Flexibility by state and federal regulators in complying in permit conditions associated with monitoring, thereby allowing dischargers to contribute resources toward regional monitoring programs.
- Collaboration and networking should be encouraged to include federal, state, tribal, local government, and NGO partners.
- Integration of monitoring, observation and research activities. The sampling/program design must be appropriate to the questions being asked. Stratified random sampling design should be encouraged to answer the question "What proportion of a region's marine environment is healthy or impaired?"
- Standardization in the form of comparable methods, training exercises, and quality assurance. Such standardization should be internal to the regional monitoring program and should also be in accordance with federal standards. While data management systems may not be identical between states and regions, they should be consistent with minimum federal standards for distributed data sets. This will facilitate data and information exchange, and will ultimately allow for national scale assessments.

CSO Recommendation #4 – Create indicators of coastal and ocean health

National and regional monitoring programs should support the development and implementation of indicators of ecosystem health (e.g., natural and anthropogenic) and their dissemination to the public.

Action: NOAA, EPA, USGS and DOI should be directed to work cooperatively in the development and implementation of ecosystem health indicators.

Rationale: Any national monitoring program should have indicators that provide comparability between regions and allow for national scale assessments. While a large variety of monitoring parameters and properties of ecosystems must be monitored by various agencies and other organizations in our coastal waters, not all of these will allow valid comparisons across a national scale.

There are really two kinds of indicators, both of equal importance: 1) human health related indicators such as seafood quality and microbial contamination in recreational waters, and 2) ecosystem health indicators. Indicators must be based on standardized measurements; these indicators must be amenable to use on a national scale in order to provide comparisons of environmental quality between states and regions. Furthermore these indicator measurements must lend themselves to clear, straightforward, and understandable interpretation for resource managers as well as the general public. The Coastal Research and Monitoring Strategy Workgroup (Clean Water Action Plan: Coastal Research and Monitoring Strategy, September 2000) have made recommendations regarding the selection of reliable indicators.

Proposal: A Federal Interagency Ocean Monitoring Committee, discussed above, acting in cooperation with state, tribal, and NGO representatives, should develop a common set of environmental indicators to be used in a national coastal waters monitoring program, and in participating state and regional programs. This set of indicators should meet the criteria as described by the Coastal Research and Monitoring Strategy Workgroup. These criteria should:

- be quantifiable in a simple manner;
- be responsive to a broad range of conditions;
- be sensitive to problematic conditions or concerns;
- resolve meaningful differences in such environmental conditions;
- provide an integrated view of effects over time and space;
- provide reproducibility;
- be amenable to reference information by which to judge the results; and
- be comparable across differences in time and space.

In addition, any indicator selected must be easily understood or interpreted for common use by government and the public alike.

SECTION 3: STRENGTHENING COASTAL AND OCEAN RESEARCH

CSO Recommendation #1 – Support regional marine research

The manner in which research is conducted must recognize that the boundaries of coastal ecosystems do not conform to political subdivisions at any scale. Understanding and managing regional features of ecosystems such as coastal ocean currents, estuarine habitats, and drainage basins often requires a regional approach. The overriding importance of regional-scale research programs is well documented.[2]

Action: Establish regional marine research programs that: address regional or large-scale impacts; contribute to solving more than one issue of regional concern; address priority research questions; and ensure the research builds upon and does not duplicate existing efforts.

Rationale: States have jurisdiction over and management responsibility for many marine and coastal resources, uses, and activities within the limits of state waters, which in most cases extend three nautical miles seaward from a base shoreline. These near-shore areas are a relatively narrow band of coastal waters between the terrestrial environment and the much larger and more dynamic marine environment. A region-scale understanding of natural processes and human activities is often required to support appropriate marine resource management and policy at a local or state level. Region-scale marine scientific research is thus needed to build this region scale context.

The marine environment presents two principal problems for state management: one is that ocean conditions and ecosystem conditions within state waters are influenced by and connected to conditions that may extend many hundreds, if not thousands, of miles beyond state jurisdiction. The other problem is presented by highly migratory uses and resources, the management of which, often must consider and respond to uses and management regimes far beyond state borders. The environmental setting for state management of marine resources is thus embedded within a larger marine ecosystem context that is regional by definition.

State managers face institutional problems in undertaking rational, comprehensive, integrated management of marine resources. States are responsible for a wide range of resources and uses. Thus the need for information to support appropriate planning and management of marine ecosystems, resources, and uses can be equally broad and diverse. Scientific research and monitoring to obtain needed information may be required over spatial scales that are far beyond state jurisdiction, by a scale of effort that is beyond the ability of states to support, and over time scales far longer than states are expected to act. Basic marine research or monitoring has historically been the purview of academic and federal research programs, so few if any state agencies have sufficient scientific staff to

[2] *Bridging Boundaries Through Regional Marine Research*, NRC, 2000

undertake needed marine research even at a small level of effort and have little familiarity with the status of marine science and research programs. Integration of state agency programs with marine research programs is often a matter of personal interest and commitment rather than long-term institutional relationships.

Although regional research programs can provide states with necessary information, they also have significant limitations for states and are not a substitute for more localized or process kinds of research and monitoring. Regional research programs must be on-going and de-coupled from the demands for information to address short-term management needs. The time and space scales of regional research do not often match the needs of state or local managers. Regional marine research requires long lead times to plan, fund, and conduct, often far longer than the need for information to support a management decision. Regional research, no matter how well conceived and valuable, may ultimately yield information that is broadly applicable to understanding phenomena at a regional scale but may not be directly applicable to solving a specific management issue or need.

Regional research programs must be created and actively maintained through a highly organized process that involves states, federal agencies, academic, and private interests. Traditional peer-reviewed competitive proposals must be integrated with other more programmatic approaches to marine scientific research and monitoring. Effective participation in such a process will require that states have the professional capacity to work at the bridge between science, policy, and management of a broad range of needs and to support follow-up or ancillary research programs that may be more localized or shorter term to address specific management needs.

Proposal: As described in the attached matrix a national program of networked regional research initiatives can be created with varying degrees of complexity – from the most simple to the sophisticated. Two key issues are addressed – the array of functions a network must provide and its form. To make the process for creating a network fully transparent a range of options are identified and a recommendation is offered (see shaded boxes).

CSO Recommendation #2 - Build state capacity to use research

To maximize the value of enhanced coastal and ocean research programs the federal government should partner with the states to ensure potential users have the capacity to use the products and results of this research.

Action: The effectiveness of existing programs (e.g., an amended CZMA and the NERRS Coastal Training Program, Sea Grant Education efforts, etc.) should be assessed and augmented. In addition, an enhanced interagency effort to make the results of current research programs more accessible is required.

Rationale: State coastal management programs, including their local and regional partners, need to develop and maintain the capacity to use the results of our scientific enterprise to make informed management decisions. While there are multiple issues in

play this paper focuses on two – locating the research required and using it in the decision-making process.

Proposal:

A. Making the results of federal agency research more accessible – Based on informal surveys of coastal managers they identified the following methods that require further analysis and consideration:
    - Managers need improved access to the scientific community and the realm of research being conducted;
    - More powerful and focused web-based search engines;
    - An "Online Librarian" that can assist in locating people, conducting literature reviews, locating annotations, etc.;
    - Increased support for issue-driven workshops and conferences where research results are discussed and synthesized (e.g., routine annual science to management exchanges on a regional or topical basis);
    - List-serves pertaining to specific management issues;
    - Accessible abstracts and methods to obtain more detailed information;
    - Training workshops on using the web as a research tool;
    - Use metadata and GIS tools to disseminate research results;

B. Building the capacity of local and state coastal management decision-makers – A more robust partnership of local, state and federal interests is required to build and maintain the capacity of state and local resource managers to make sound coastal management decisions. Examples of methods to accomplish this include:
    - Augment the National Estuarine Research Reserves "Coastal Training Program";
    - Increase the GIS training capacity of the Coastal Services Center and provide on-going consultation and assistance;
    - Grant programs to procure the technical capacity that is then transitioned into state or local budgets. These people would be responsible for identifying relevant research and analyzing the policy implications of the research results;
    - Increase the pace of science translation and identify the policy implications of the research.

Shaping a Federal Regional Research Program

An Initial Proposal[1]

Functions	Simplicity →			Sophistication
Mission - national network of regional programs	Detect, assess, & predict effects of stresses on ecosystems		Evaluate local changes that are influenced by climate, ocean circulation, resource exploitation and land use	Integrate research and monitoring to predict consequences of human actions on ecosystems
Operational Focus	Subtidal and near-shore coastal	Inshore	Coastal	Watersheds and Blue Water/Ocean
Connection with other research programs	Regional research supported by this program	Program coordinated within each region with other federal research on region's priority management issues		Coordination with all regional scale government, volunteer and academic research
Program design & implementation	Agency driven top-down regional plans based on selected management issues	Integrated agency, scientist and community regional plans based on selected issues	Integrated agency, scientist and community regional plans with comprehensive scope	Nationally coordinated regional research and monitoring plans that are locally relevant
Data management	Rely on current mechanisms	Web links to distributed databases, spatial references, & metadata requirements		Distributed & linked (e.g., archival and retrieval)
Data synthesis & communication w/ managers	Routine production of research results			Timely analysis of trends, assessment and information to resource managers & policymakers
Links to management community	Managers articulate research needs	Routinely engage managers and provide feedback		Explicit connection and accountability to coastal managers (e.g., local, state, etc.)
Links to ongoing monitoring	Spontaneous – no formal connection	Identifies priorities linked to monitoring	Active proponent for regional monitoring	Supports and conducts monitoring
Links to regional organizations	Independent of relevant regional organizations	Create supportive & nurturing relationships		Formally integrate relevant organizations

[1] The Coastal States Organization is proposing the formation of a regional research program that funds peer-reviewed research and coordinates relevant federal and state research programs addressing the nation's pressing coastal and ocean management issues. Envisioned are a series of regional programs that are networked into a national initiative. Among the many options for such a program this proposal identifies those aspects (shaded boxes) that should be pursued within the next five years. After this time the program should be strategically expanded.

Form of Network	Simplicity →			Sophistication
Federal structure	A single federal agency (e.g., NOAA) with dedicated program office, clear OMB priority to coordinate related programs and leadership			Inter-agency coordinated by National Oceanographic Partnership Program & individual MOA with agencies (e.g., define roles, responsibilities, balanced/sustained funding)
Type of regional organization	Stakeholder based Board w/option for international involvement			Board with binding MOA with each state (governor or legislature)
Geography	Regional by political subdivision			Biogeographical (e.g., nine regions of the US)
Governance/decision-making	5-10 year strategy and annual implementation plans			
Operating budget	Sustained, predictable federal funding that enables regional research	Incremental growth with incentives based on results		Significant ongoing matching initiative from public and private sources
Funding sources	Provided by single lead agency	Multi-agency support		Multi-agency support with regional matching funds

SECTION 4: IMPROVING OUR EDUCATION INFRASTRUCTURE

CSO Recommendation #1 – Support science translation into information for decision-makers

An interagency effort co-led by NOAA, EPA, DOI and the Department of Agriculture (USDA) is required to significantly expand the movement of research findings into the hands of coastal and ocean managers. This commitment to using science in decision-making needs to compliment and be integrated into the nation's current investment in research/science programs.

Action: Federal agencies responsible for existing coastal and marine research programs need to be directed to review and amend their program guidelines to ensure adequate emphasis is placed on conveying the results of these research programs to managers. Successful models exist (e.g., USDA and Sea Grant extension agents, NOS expert directories, interactive web sites, NEERS Coastal Training Programs, NOAA Science Advisory Board, etc.) that need to be bolstered.

Rationale: We need to significantly expand research efforts, as we are just beginning to understand how estuarine, littoral, and offshore ecosystems operate. In addition, we need to vastly improve the methods of making scientific data, trends, and research methods available to coastal and ocean managers. Even with the limited research currently being done, our methods for making good science and research available to coastal and ocean managers is severely lacking, with the result that resource management decisions continue to be made in a relative void.

Three models are used here to identify approaches that combine scientific information with the need to translate data to those people who make critical decisions about the use of coastal and marine resources. First, the Gulf of Maine Council on the Marine Environment involving Canadian and American state, provincial, and federal government agencies, as well as non-governmental organizations, has recognized the disparity between on-going scientific efforts and the relative lack of information that makes its way to resource managers. Earlier this year, the Council hired its first science translators as part of a three-year pilot program to address this issue.

In the same region, the Gulf of Maine Ocean Observation System (GoMOOS) has been operational since 2001. Through a system of land-based radar, satellites, and buoy platforms located from Nova Scotia to Massachusetts, real-time information is relayed to the GoMOOS web page on weather and ocean conditions for scientific and commercial applications. In fact, one of the first primary users of the GoMOOS system were the shipping pilots of Penobscot Bay and the Bay of Fundy. This relatively new system has tremendous potential for expanding not only the type of data collected, but also disseminating that information to a virtually limitless audience.

Third, the Coastal Training Program (CTP) was established through the National Oceanic and Atmospheric Administration (NOAA) to deliver training to coastal decision-makers through the 25 National Estuarine Research Reserves. Using partnerships involving state Coastal Zone Management programs, the Sea Grant system, and others, the CTP seeks to provide relevant training on a host of coastal issues – erosion, habitat monitoring and protection, and environmentally-friendly landscaping techniques – to municipal officials, state permitters, and others.

Proposal: The White House Office of Science and Technology Policy and National Academy of Science needs to work cooperatively to assess and recommend specific mechanisms to improve the flow of research results to managers and decision-makers.

CSO Recommendation #2 – Develop and implement national coastal and ocean sciences education standards that result in a scientifically literate populace and augment existing programs

Actions: There are a series of actions required to ensure citizens of all ages have a scientifically grounded understanding and appreciation of the oceans and their relevance to everyday life. These include:

The Governing Board of the National Research Council, charged with the development of the National Science Education Standards (NSES), should be directed to prepare a coastal and ocean sciences companion document to the NSES. Although the ocean is an integral element for economic development, national security and quality of life, the ocean and coastal sciences are not adequately represented in NSES example lesson and assessment materials. Efforts should be directed toward assessing the availability of ocean marine environment research-based curricular materials, identifying exemplary materials aligned with the NSES and supporting professional development for educators in the delivery and development of NSES-based ocean and coastal science materials.

The Office of Science and Technology Policy should request the National Ocean Partnership Program (NOPP) and the National Academy of Sciences to develop a NSES companion oceans document that provides greater detail on ocean concepts and assessment techniques that states might address in their applicable standards-based learning efforts.

Congress should authorize and appropriate funding directly to the NOPP for a sustained education initiative that implements the companion oceans document.

State ocean science education programs should be enabled, through technical assistance and funding, to integrate these ocean concepts into ongoing state educational reforms and standards. Possible avenues to channel this support include the NSF/Center for Ocean Science Education Excellence, the Coastal Zone Management Act, and the National Sea Grant Program.

The Governing Board of the National Research Council, charged with the development of the National Science Education Standards (NSES), should be directed to formally include coastal and ocean sciences in the NSES.

Rationale: The Nation needs to develop a slate of ocean and coastal concepts that are used to help the public understand the relationship of these concepts to areas of science, mathematics, geography, and history. This knowledge base will incorporate connections between the science of the oceans and coasts and quality of life, national security, and economic development.

Our goal is to integrate ocean and coastal sciences research into all avenues of public education through existing education and outreach programs.

Proposal:

A. Develop and implement strategies that infuse coastal and ocean sciences concepts into K-16 textbooks;
B. Use a stakeholder-based process to define coastal and ocean sciences literacy concepts and establish linkages to the existing national standards that will strengthen science education;
C. Revise existing exemplary K-16 coastal and ocean sciences curricular materials and align these materials with the National Science Education Standards.
D. Facilitate the use of the national infrastructure (e.g., ocean exploration, observing, monitoring, etc.) to advance ocean literacy and strengthen science and technology education. On-going, real-time, collection of surface and sub-surface oceanographic data provide an opportunity for a variety of exciting simulations and hands-on learning experiences for the public, students, and teachers that will foster awareness and understanding about ocean sciences and technologies. It can serve as the foundation for an array of public service announcements, instructional materials, museum exhibits, and website activities that excite and engage a large segment of the public about the oceans. Public involvement in these activities will help "bridge the gap" between the public and research communities, thereby demonstrating the need for continued support of ocean and coastal systems.

CSO Recommendation #3 – Strengthen training programs at national and regional scales

There is great need for scientists to work with coastal managers to strengthen and enrich coastal decision-making capabilities. To meet this need, strong partnerships should be developed between the National Estuarine Research Reserve System (NERRS), state Coastal Zone Management (CZM) Programs, Consortium on Oceanographic Research and Education, National Marine Sanctuary Program, National Estuary Programs, the emerging Centers for Ocean Science Education Excellence (COSEE) and Sea Grant to deliver science-based information and training for the coastal management community. Use of technology-based delivery systems such as distance learning and the Web can be

particularly useful for integrating data products and services developed from coastal observing systems. Metrics to evaluate the success of these efforts in a scientific and meaningful way also need to be established.

Action: Amend the CZMA to 1) create an intra-agency training and education program to coordinate efforts among NOAA (NERRS, state CZM programs, National Marine Sanctuary Program, Coastal Services Center, Sea Grant) and external partners (COSEE, CORE, NSTA, NMEA) and 2) authorize and appropriate funds for an integrated training program at regional and local scales.

Rationale: Effective decision-making at the local and state level requires informed and articulate managers. A plethora of programs exist with compatible education and training missions that need to be integrated and delivered in a more effective manner.

Proposal: Initial steps to implement this recommendation include a national inventory of coastal and ocean training programs; an assessment of the gaps and duplication of effort; and methods to implement a sustained, coordinated and effective training effort.